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(54) **Heating device comprising a heat exchanger system**

(57) The present invention relates to a heating device adapted for heating a fluid comprising a heat exchanging system (1) having means for passage of at least one fluid (2, 3), a mounting block (6) on which the heat exchanging system (1) is mounted comprising at least one fluid flow inlet (10) of a fluid to be heated, and at least one fluid flow outlet (11) of the same fluid that has been heated and a fluid bypass system (16) arranged between the at least one fluid flow inlet (10) of a fluid to be heated and the at least one fluid flow outlet (11) of the same fluid that has been heated, wherein the fluid bypass system (16) comprises at least one preset fluid flow obstruction means (17) regulating excess fluid flow, in a preset manner, of the fluid to be heated between the at least one fluid flow inlet (10) of a fluid to be heated and the at least one fluid flow outlet (11) of the same fluid that has been heated.

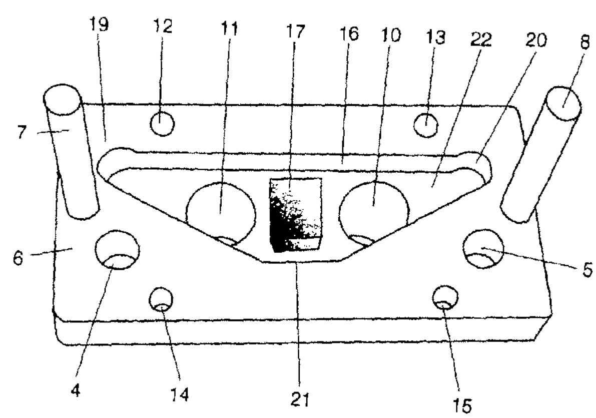

FIG. 1

EP 1 411 311 A1

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Description

[0001] The present invention relates to the field of heating apparatus or devices, in particular, comprising a heat exchanger system. The invention will be more particularly described and exemplified with respect to a heating device for heating water in a swimming pool.

[0002] Currently, domestic swimming pool heating is performed via a hydraulic system using a heat exchanger. There are two methods of implementation of such a system :

- using a tubular heat exchanger, with either an array of tubes or a drum, that is usually made from metal or composite material ; these systems have the advantage of being able to cope with the total volume of fluid to be heated pumped through the system;
- using a plate heat exchanger, whereby the plates are made of titanium or stainless steel, that are enclosed between a mounting block and a cover plate ; these systems can be easily unmounted, serviced, are adaptable and are also very efficient with respect to energy transmission.

[0003] The disadvantages of the tubular heat exchange system are that they can not be unmounted, are not adaptable, and have very poor heat transmission performance.

[0004] On the other hand, the disadvantages of the plate heat exchange system are that the dimensions of the conduits formed within the plates for passage of heating fluid and the plate geometries means that it is impossible to handle the totality of the volume of fluid to be heated being pumped through the system. This problem is currently solved by only pumping a small part of the total volume, say 10 to a maximum of 20% thereof, through the heat exchange plates. The rest of the volume of fluid to be heated is bypassed outside of the heat exchange system. The problem with this is that it is necessary for the swimming pool vendor or fitter, and more often than not the local artisan, such as a plumber or mason, or even the buyer, to create, install and set the bypass manually to obtain the maximal flow rate with maximal heat transmission. Such bypasses are generally made of PVC material and connected in parallel to, but outside of the heat exchange unit. This adds to the complexity and bulk of the system as a whole.

[0005] The present applicant has sought to overcome the problems and disadvantages of the prior art. Accordingly, it is an object of the present invention to provide a heating device adapted for heating a fluid, and preferably water for a swimming pool, comprising :

- a heat exchanging system having means for passage of at least one fluid ;
- a mounting block on which the heat exchanging system is mounted comprising at least one fluid flow inlet of a fluid to be heated, and at least one fluid flow outlet of the same fluid that has been heated ; and
- a fluid bypass system arranged between the at least one fluid flow inlet of a fluid to be heated and the at least one fluid flow outlet of the same fluid that has been heated,
- wherein the fluid bypass system comprises at least one preset fluid flow obstruction means regulating excess fluid flow, in a preset manner, of the fluid to be heated between the at least one fluid flow inlet of a fluid to be heated and the at least one fluid flow outlet of the same fluid that has been heated.

[0006] In a preferred embodiment of the present invention, the fluid bypass system is a chamber and the at least one preset fluid flow obstruction means is located within the chamber.

[0007] In another preferred embodiment of the present invention, the fluid bypass system is a chamber housed within the mounting block and the at least one preset fluid flow obstruction means is located within the chamber.

[0008] In yet a still more preferred embodiment of the present invention, the fluid bypass system is a chamber formed within the mounting block and the at least one fluid flow obstruction means is located within the chamber. This particular set up is very advantageous in that it reduces the both the size and the weight of the total installation, since the bypass is actually part of the mounting block to which the inlet and outlet of the fluid to be heated are connected. This set up also enables a temperature sensor to be fitted within the chamber, which is connected to a control unit, by any conventional means, such as an electrical, fibre optic or wireless connection, e.g. via radio or light waves. In a particularly preferred embodiment, the temperature sensor may be slipped inside a finger, or be screwed into a screw fitted metallic insert.

[0009] The applicant has also advantageously and surprisingly determined that the chamber of the fluid bypass system can be of a general shape that will enable maximum volume throughput of the fluid to be heated without exceeding the mechanical resistance of the material from which it is made due to the pressure caused by the turbulence of the circulating fluid. In particular, the general shape of the chamber, when it is formed or located within the mounting block, is preferably such that the mounting block is still sufficiently mechanically resistant to prevent buckling of the heat exchanging plates when they are mounted and fixed, e.g by screws, to the mounting block. Accordingly, the most preferable shape for the chamber is roughly triangular. In addition, the applicant has determined that it is most advantageous when the chamber has substantially rounded pockets located at at least two of the corners of the triangle, and the third angle is substantially truncated. The reason for this is so that the mounting block, when the chamber is formed or located therein, still retains

enough material for it to stand up to the mechanical constraints of the plates that are fixed against it under pressure, e.g. by screwing of a cover plate.

[0010] According to another preferred embodiment of the invention, the at least one fluid flow obstruction means comprises a wedge, a plate, a baffle, a deflector, a substantially rectangular block, a generally Y-shaped block, a generally T-shaped block, a generally I-shaped block, a tube, a sphere, a cone, and a truncated cone. Most preferably, the fluid flow obstruction means has a generally parallelepiped shape. Preferably, the flow obstruction means is made of a plastic material, but can also be made of metal or any suitably resistant material adapted to the pressures that are generated by the turbulence of the fluid to be heated. Alternatively, the flow obstruction means can even be formed as part of the chamber, and where the latter is formed in the mounting block, as part of the mounting block, for example via molding, cutting, grinding, honing or metal working. Additionally, the flow obstruction means can provide supplementary mechanical support to the mounting block vis-à-vis the mechanical constraints of mounting the heat exchanging plates, as discussed above in relation to the shape of the chamber. Where the flow obstruction means is a separate element, it can be fixed to the fluid bypass means using traditional fixing means, such as soldering, screwing, gluing, welding, nailing and the like. It should be borne in mind that the flow obstruction means is preset during manufacture of the heating device to obtain the maximal flow rate with maximal energy transmission, as a function of the volume of fluid to be heated that is going to be pumped through the heating device. As will be readily understood, the term "preset" used within the context of the present specification indicates that the parameters of the fluid flow obstruction means, such as size, shape, angle with respect to fluid volume flow, displacement volume, surface rugosity, and the like are determined and fixed during manufacture or assembly of the heating device at the manufacturing plant. In this way, the installer, vendor or home user does not have to face the problem of manually setting up a bypass system and fiddling with the setting in the hope of getting it right. Preferably, the at least one fluid flow obstruction means is fixed to the chamber between the at least one fluid flow inlet of a fluid to be heated and the at least one fluid flow outlet of the same fluid that has been heated. The dimensions and number of fluid flow obstruction means are designed to obtain optimal performance, both in terms of energy transmission and reduction of noise, and thus may vary according to the dimensions of the chamber and the volume of fluid to be heated that is being pumped and bypassed through the system. As a general rule however, the height of the fluid flow obstruction means will generally represent about 3/5 to about 4/5 the height of the chamber. This means that the heating device can be adapted to all situations and will be guaranteed to function optimally without the need for human intervention on the bypass, whilst at the same time limiting the size of the equipment to be installed.

[0011] In another preferred embodiment, the flow obstruction means can have a smooth or a rough surface, depending on whether it is desired to increase or decrease the effects of turbulence within the fluid bypass means.

[0012] The mounting block also has an important role in the present invention, since in a particularly preferred embodiment, it has the chamber of the fluid bypass system housed or formed within it. Consequently, the mounting block can be made from a material that can withstand the mechanical constraints, such as pressure, and wear and tear, caused by the turbulence of the pumped fluid flow inside the bypass chamber. Preferably, the mounting block is formed of a single piece of material. More preferably, the mounting block is formed of a composite material. Even more preferably, the mounting block is made of a material comprising expanded plastic, moulded plastic, ceramic and/or metal. Suitable plastic materials are ABS, PVC, high impact plastic, high density polypropylene, high density polyethylene, expanded polyurethane or polyamide, and the like. Similarly, the metals can be chosen from titanium, aluminium, stainless steel, galvanized steel, and the like, and the ceramic material from known high impact resistant ceramics. It is preferred that the mounting block be made of a material that is as light, yet as resistant as possible, and for this reason, expanded plastic materials such as ABS or expanded polyurethane are preferred.

[0013] In a most preferred embodiment, the heat exchanging system is in direct contact with the fluid bypass system. In this case, it is also preferable that the chamber of the fluid bypass system be in direct contact with the heat exchanging system, since this will ensure a direct transfer of the fluid to be heated into the heat exchange system, whilst at the same time ensuring an adequate bypass, i.e. optimal functioning of the heating device.

[0014] In still yet another alternatively preferred embodiment, the heat exchanging system is in indirect contact with the fluid bypass system.

[0015] With regard to the heat exchanging system used, the invention preferably uses a heat exchanging system based on a set of heat exchange plates, that are formed in such a way that when two or more plates are laid one on top of the other, a heating fluid passageway is formed enabling heating fluid to flow and dissipate its thermal energy to the plates. Such heat exchanging systems are well known in the art, and the plates are often made of stainless or galvanized steel or titanium. The heating fluid provided to the heat exchanging system will generally come from a primary source of heat, such as solar power or a burner powered by gas, petrol, fuel, coke, coal, oil or electricity. Since domestic installations, for which the current inventive device is preferably designed, often use these types of burners, they will readily

provide a constant source of primary heat that can be circulated into the heat exchanging system of the heating device of the current invention ir order to provide heat by thermal exchange to the fluid to be heated. The heat exchanging system also provides for passage of the fluid to be heated, but the two fluid sources do not come into direct contact. The fluid to be heated obtains its thermal energy by transfer from the plates that have been heated by the fluid from the primary source of heat. Since the passage for the fluid to be heated is relatively small in diameter and total surface area, the total volume of fluid to be heated being pumped into the heating device can not pass through the heating system. This is why the heating device of the invention is provided with flow bypass means comprising fluid flow obstruction means, to divert fluid to be heated back out of the heating device.

[0016] Although the present invention has been described with respect to a heating device for use in heating water in a swimming pool, it is to be understood that such a heat exchanger system and device comprising it can also be used, e.g. for domestic hot water supply requirements, whereby the heat exchange system could be connected to a boiler or gas, coal or oil fired burner that is used for general radiation heating of a building, and the water to be heated for the hot water supply could be pumped through from and back to a storage tank via the heating device of the present invention.

[0017] The present invention will now be exemplified in more detail through the description of a most preferred embodiment, and making reference to the non-limiting figures in which :

- Figure 1 represents a top side perspective view of part of a preferred heating device of the present invention ;
- Figure 2 represents a closer top side view of the same part of the preferred heating device of Figure 1 ;
- Figure 3 represents a bottom side view of the same part of the preferred heating device of Figure 1 ;
- Figure 4 represents a side view of the preferred heating device of Figure 1.

Detailed Description of the Invention

[0018] In Figures 1 to 3, part of a preferred heating device is shown, with the assembled device being represented in Figure 4. The device, which is adapted for heating fluid, comprises a heat exchange system 1, not shown in Figure 1 but displayed in Figure 4. The heat exchange system 1 comprises one or more heat exchange plates 2, 3, preferably between two and thirty plates. These plates are generally made of stainless or galvanized steel or titanium, since such materials have high resistance to corrosion and relatively high thermal conductivities. The resistance to corrosion is advantageous when the fluid to be heated is water from a swimming pool, since such fluids generally contain corrosive chemical substances that are necessary for microbiological control, such as chlorine and salts, or other oxidative or reductive active species, such as the hypochlorite anion. The heat exchange plates are provided with at least one passageway that allows fluid to flow between the plates. These passageways are not shown in the figures since the kind of plates that are useful in the invention are well known in the art and can be readily acquired in commerce. The plates comprise a passageway for fluid flow of a fluid that is hot, or has a greater thermal energy than the fluid of the swimming pool to be heated. This hot fluid is typically known as a primary source, and is often generated by a primary source heater means, such as solar power, or a burner, that may be electrically powered, or powered by combustible fuels, such as coke, coal, gas, petrol, fuel and oil. In the case of application of the present invention for use with a domestic swimming pool, the hot fluid can come from the household central heating system. The primary heater source that provides the fluid with greater thermal energy enters and leaves the heat exchange system via an inlet 4 and an outlet 5 respectively, provided in a mounting block 6, on which the heat exchange plates 2, 3 are mounted. These plates 2, 3 are stacked one on top of the other with the aid of plate guides 7, 8 that extend substantially vertically, from the mounting block 6, and have the general shape of a rod. These plate guides can be made of metal, wood or plastic, as long as they are adapted for the application envisaged, but such choice of materials for the guides is within the general knowledge of the skilled person. A cover plate 9 serves to hold down the top heat exchange plate and provide a seal with respect to the fluid passageway provided within the latter. The cover plate 9 can be made of metal, for example the same material as the heat exchange plates, or it can also and more preferably be made of the same material as the mounting block 6. As mentioned previously, the mounting block can be made of metal, such as stainless or galvanized steel or titanium, expanded plastic, moulded plastic, and/or ceramic, but preferably it is made from plastic material, and more preferably from expanded plastic materials, such as expanded polyurethane and ABS plastics, since theses are relatively light weight and are generally classed as high impact resistant materials. The cover plate 9, heat exchange plates 2, 3 and mounting block 6 are connected in a sealtight manner together by a classical mounting system, comprising for example threaded bolts or rods and corresponding nuts or a clamping system, not shown on the figures, for which bores 12, 13, 14, 15 are provided in the mounting block 6 and the cover plate 9.

[0019] As mentioned previously, Figures 1 and 2 represent top side perspective views of part of the heating device of the present invention, and in particular the mounting block 6. As can be seen in these figures, the mounting block serves as a base for the plate guides 7, 8, which extend substantially vertically therefrom. The

mounting block 6 also comprises at least one fluid flow inlet 10 of a fluid to be heated, and at least one fluid flow outlet 11 of the same fluid that has been heated by the heating device, which in the preferred embodiment is water from a swimming pool. The diameters of inlet 10 and outlet 11 are substantially greater than those of inlet 4 and outlet 5, and as will be apparent from the figures and the arrangement of inlets 4 and 10, and outlets 5 and 11, the respective hot or high thermal energy fluid circuit and the circuit containing fluid to be heated, i.e. the one bringing water to be heated from the swimming pool, are set counter-current to each other. It has been discovered by the present inventors that this arrangement offers the optimum performance of the heating device with respect to the fluid to be heated.

[0020] The device according to the present invention also comprises a fluid bypass system 16 arranged between the fluid flow inlet 10 of a fluid to be heated and the fluid flow outlet 11 of the same fluid that has been heated after passing through the heat exchange system. The bypass system enables optimisation of the pass through flow rate for the heating device, minimizing thermal energy loss, by redirecting a predetermined flow from the inlet 10 to the outlet 11, whilst maintaining maximum throughput through the heat exchange system. In order to do this, the fluid bypass system comprises at least one preset fluid flow obstruction means 17 regulating excess fluid flow, in a preset manner, of the fluid to be heated between the at least one fluid flow inlet 10 of a fluid to be heated and the at least one fluid flow outlet 11 of the same fluid that has been heated after passing through the heat exchanging system. In the preferred embodiment illustrated in the figures, particularly figures 1 and 2, the preset fluid flow obstruction means is a parallelepiped shaped block, that is arranged between the inlet 10 and the outlet 11. As has been mentioned previously, this block can be fixed, e.g. via a screw, bolt, nut, glue, etc, or other suitable fixing means 18 (cf. Figure 4) to the mounting block 6. Alternatively, the fluid flow obstruction means 17 can be formed as part of the mounting block 6, for example by molding. The position of the obstruction means, its size, angle, surface smoothness/rugosity in relation to the incoming and outgoing fluid flows is set during manufacture and assembly of the heating device at the manufacturing facility, as a function of the volume of fluid to bne heated, and therefor bypassed, and also as a function of the materials from which the mounting block and the device in general are made.

[0021] As is apparent from the figures, the fluid bypass system 16 is a chamber 22 and the fluid flow obstruction means 17 is located within the chamber 22, substantially in the midpoint between the inlet 10 and the outlet 11. The chamber 22 is housed, or in the preferred embodiment formed within the mounting block 6, for example when the mounting block 6 is molded from plastic or shaped from metal. The chamber 22 has a generally triangular shape, for this has been demonstrated by the applicant to be the optimal shape capable of dealing with the high mechanical shear generated by the flow of fluid in, and out, of the chamber 22 via the inlet 10 and outlet 11. It is to be noted in this preferred embodiment that the inlet 10 and outlet 11 communicate directly with the chamber 22, through the face opposite to that on which the heat exchange plates 2, 3 are mounted with the aid of the guide rods 7, 8. In this particular embodiment, the heat exchanging plates 2, 3 are also directly mounted on the mounting block 6 and therefor are in direct contact with the chamber 22, and form a peripheral sealtight contact with the latter. As an option, a seal may be provided, for example a silicon rubber torus arranged around the upper peripheral edge of the chamber 22. The generally triangular shape of the chamber 22 described previously is slightly modified in two respects, in that it has a substantially rounded pocket 19, 20 located at at least two of the corners of the triangle, and the third angle 21 is substantially truncated to give a general shape to the chamber that ressembles a clothes hanger without the hook. The rounded pockets 19, 20, which are generally circular, are substantially displaced with respect to the vertex of the triangle that runs parallel to the longitudinal axis of the mounting block 6, whereas the vertices that run to the summit of the truncated angle 21 are substantially tangential to the outer radius of the arc described by the pockets 19, 20. These pockets 19, 20 enable substantial alignment with the passageways formed in the heat exchange plates 2, 3. This enables fluid that is to be heated to flow through the plates 2, 3, by leaving chamber 22 via pocket 20. Once the fluid to be heated has finished its course through the heat exchange plates 2, 3, it will be at a higher temperature than on entry into the heat exchage system, and the fluid that is now heated will exit the heat exchange plates 2,3 and re-enter the chamber 22 via pocket 19, and from there will exit the chamber via outlet 11.

[0022] The device functions as follows when used for heating water from a swimming pool:

- hot water coming from a primary heat source is introduced into the heat exchange circuit via inlet 4 and runs through the plates 2,3 to exit the heat exchange system via outlet 5 ;
- significantly cooler water, in a larger volume than that of the primary hot water circuit is taken from the swimming pool and introduced into the chamber 22 via inlet 10. It is to be noted that the primary heat source and the cooler water are arranged in counter-current flows to each other, thus enabling optimum efficiency in heat transfer through the heat exchange plates. The obstruction means 17 is of a size, dimension and angle to the incoming cool water flow that it provides resistance, while at the same time letting cool water through which will then mix with water that has been heated leaving the heat exchange system 1 and entering the chamber 22

again. The obstruction means 17 is setup on manufacture to provide the optimum resistance and maximum flow throughput via inlet 10 of the water to be heated through the heat exchange system, which will depend on the volume of the swimming pool water to be heated. The heated water and overflow or bypassed water mix together in the chamber 22 near outlet 11, before being circulated back into the swimming pool.

[0023] The temperature difference between the inlet water and the outlet water can vary between about 0.1°C and 0.5°C, depending on the power of the heat exchanger, which is in turn adapted in size and volume flow to the to volume of the water reservoir, e.g. swimming pool, to be heated. The power of the heat exchanger also depends partly on the number of heat exchange plates provided, as well as the available heating power of the primary heat source. In general, economical heating of a swimming pool can be achieved with the invention over a period of 4 to 5 days maximum.

[0024] It is to be understood that other components can be added to the mounting block 6 and/or the chamber 22, such as, for example, an air-vent, a drainage system, anti-return valves, stop valves and the like.

[0025] Other applications of the present invention are possible, for example, in a household or any other hot water system equipping a building of any kind, whereby the device would be connected to a primary heat source, for example, a central heating heater, and the hot water for domestic use would be taken from a reservoir and introduced into the heat exchange system whilst at the same time bypassing the excess back into the reservoir.

Claims

1. Heating device adapted for heating a fluid comprising :

   - a heat exchanging system (1) having means (2,3) for passage of at least one fluid ;
   - a mounting block (6) on which the heat exchanging system is mounted comprising at least one fluid flow inlet (10) of a fluid to be heated, and at least one fluid flow outlet (11) of the same fluid that has been heated ; and
   - a fluid bypass system (16) arranged between the at least one fluid flow inlet (10) of a fluid to be heated and the at least one fluid flow outlet (11) of the same fluid that has been heated,
   - wherein the fluid bypass system (16) comprises at least one preset fluid flow obstruction means (17) regulating excess fluid flow, in a preset manner, of the fluid to be heated between the at least one fluid flow inlet (10) of a fluid to be heated and the at least one fluid flow outlet (11) of the same fluid that has been heated.

2. Heating device according to claim 1, wherein the fluid bypass system (16) is a chamber (22) and the at least one fluid flow obstruction means (17) is located within the chamber.

3. Heating device according to claim 1, wherein the fluid bypass system (16) is a chamber (22) housed within the mounting block (6) and the at least one fluid flow obstruction (17) means is located within the chamber (22).

4. Heating device according to claim 1, wherein the fluid bypass system (16) is a chamber (22) formed within the mounting block (6) and the at least one fluid flow obstruction means (17) is located within the chamber (22).

5. Heating device according to claim 1, wherein the fluid bypass system (16) is a chamber (22) and the chamber (22) contains a temperature sensor for the fluid to be heated connected to a control unit.

6. Heating device according to claim 1, wherein the fluid bypass system (16) is a chamber (22) and the chamber (22) is roughly triangular in shape.

7. Heating device according to claim 5, wherein the chamber (22) has a substantially rounded pocket (19, 20) located at at least two of the corners of the triangle, and the third angle is substantially truncated (21).

8. Heating device according to claim 1, wherein the at least one fluid flow obstruction means (17) comprises a wedge, a plate, a baffle, a deflector, a substantially rectangular block, a generally Y-shaped block, a generally T-shaped block, a generally I-shaped block, a tube, a sphere, a cone, and a truncated cone.

9. Heating device according to claim 1, wherein the at least one fluid flow obstruction means (17) has a generally parallelepiped shape.

10. Heating device according to claim 1, wherein the fluid bypass system (16) is a chamber (22) and the at least one fluid flow obstruction means (17) is fixed to the chamber (22) between the at least one fluid flow inlet (10) of a fluid to be heated and the at least one fluid flow outlet (11) of the same fluid that has been heated.

11. Heating device according to claim 1, wherein the mounting block (6) is formed of a single piece of material.

12. Heating device according to claim 9, wherein the mounting block (6) is formed of a composite mate-

rial.

13. Heating device according to claim 1, wherein the mounting block (6) is made of a material comprising expanded plastic, moulded plastic, ceramic and/or metal.

14. Heating device according to claim 1, wherein the heat exchanging system (1) is in direct contact with the fluid bypass system (16).

15. Heating device according to claim 1, wherein the heat exchanging system (1) is in indirect contact with the fluid bypass system (16).

16. Heating device according to claim 14, wherein the fluid bypass system (16) is a chamber (22) and the chamber (22) is in direct contact with the heat exchanging system (1).

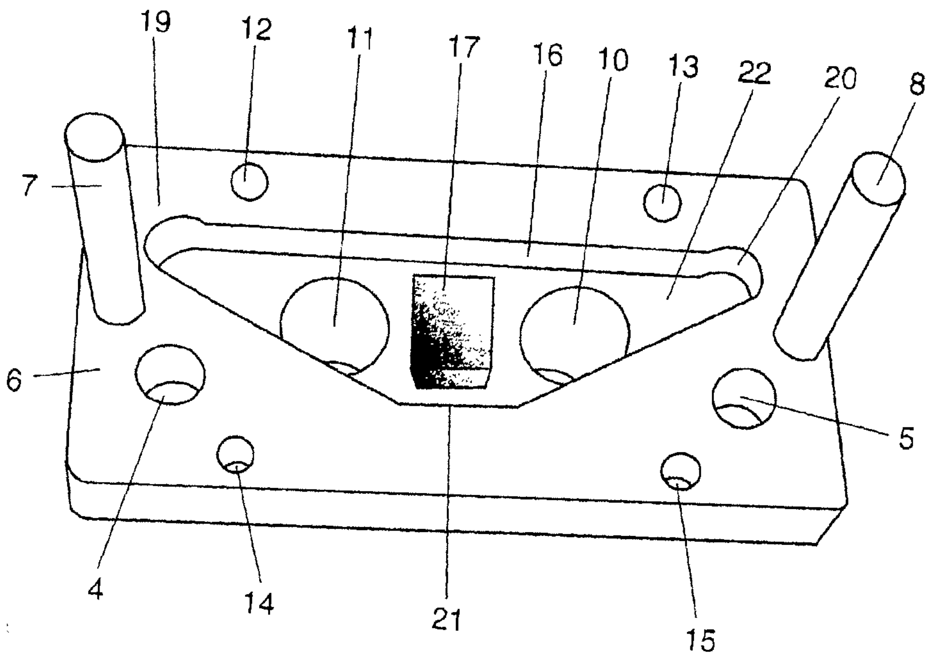

FIG. 1

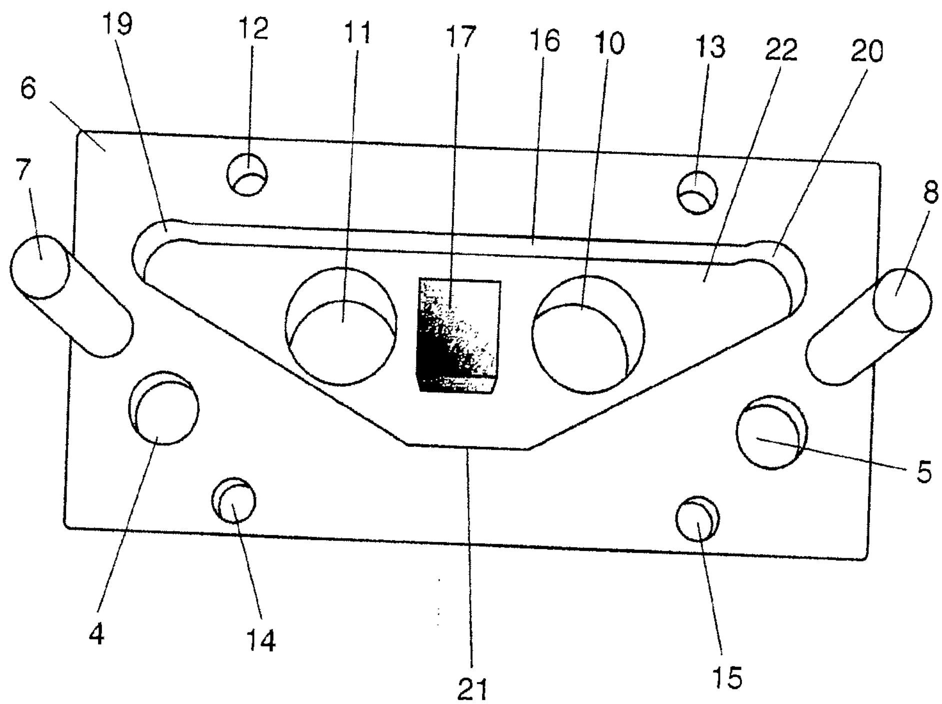

FIG. 2

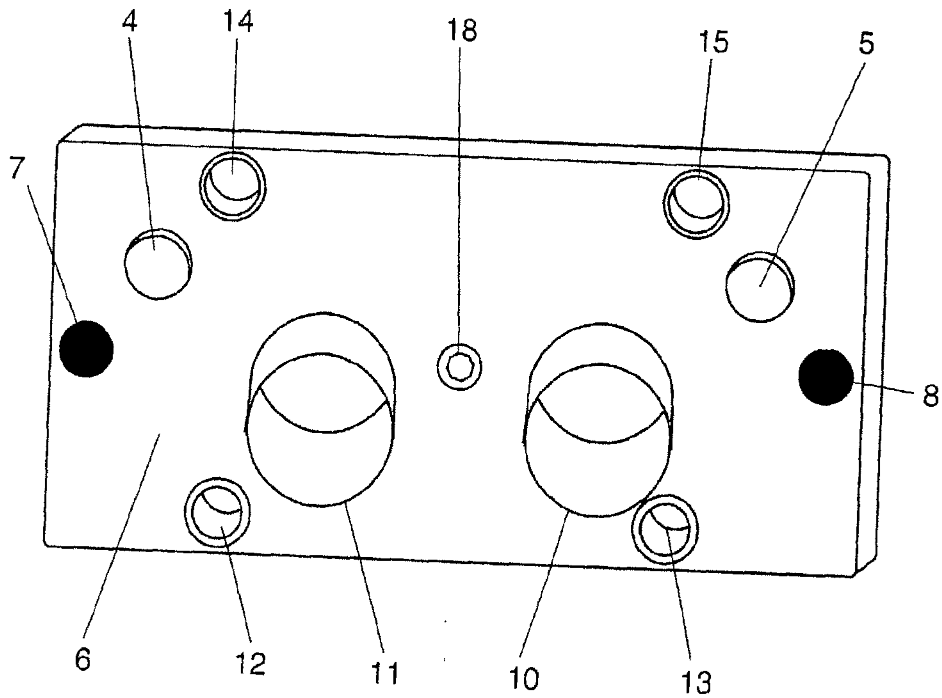

FIG. 3

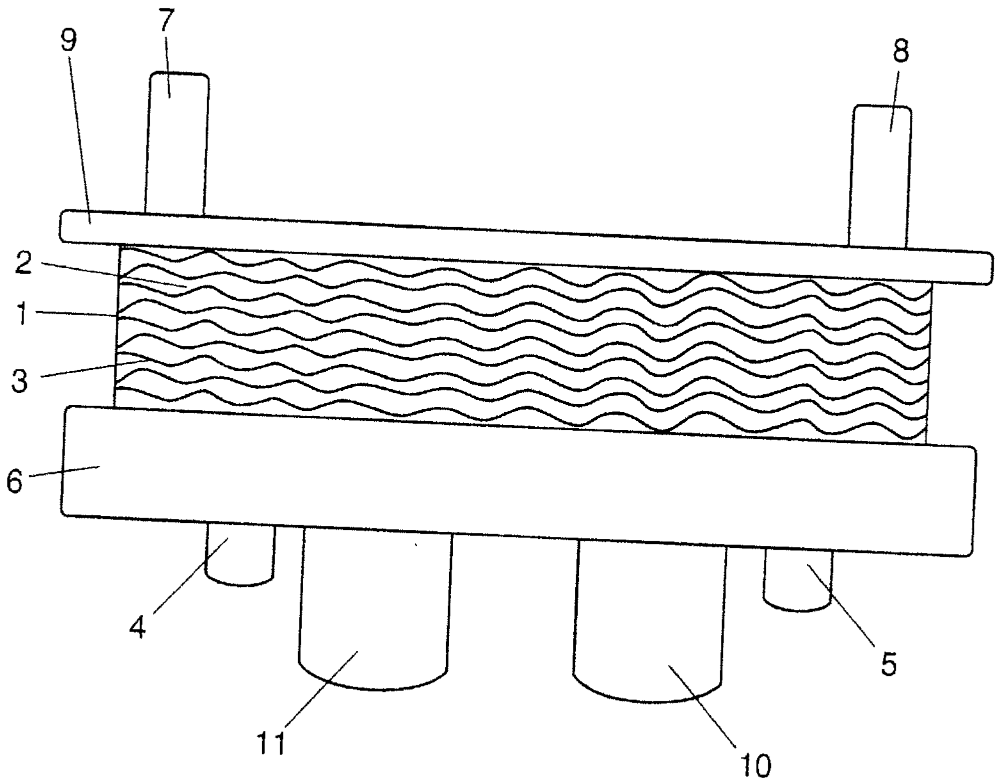

FIG. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 29 2575

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 5 575 329 A (SO ALLAN K ET AL) 19 November 1996 (1996-11-19) * column 2-4; figures 6-10 *	1-4, 9-12,16	F28D9/00 F28F27/02
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)
F28D
F28F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	27 March 2003	Bain, D

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